

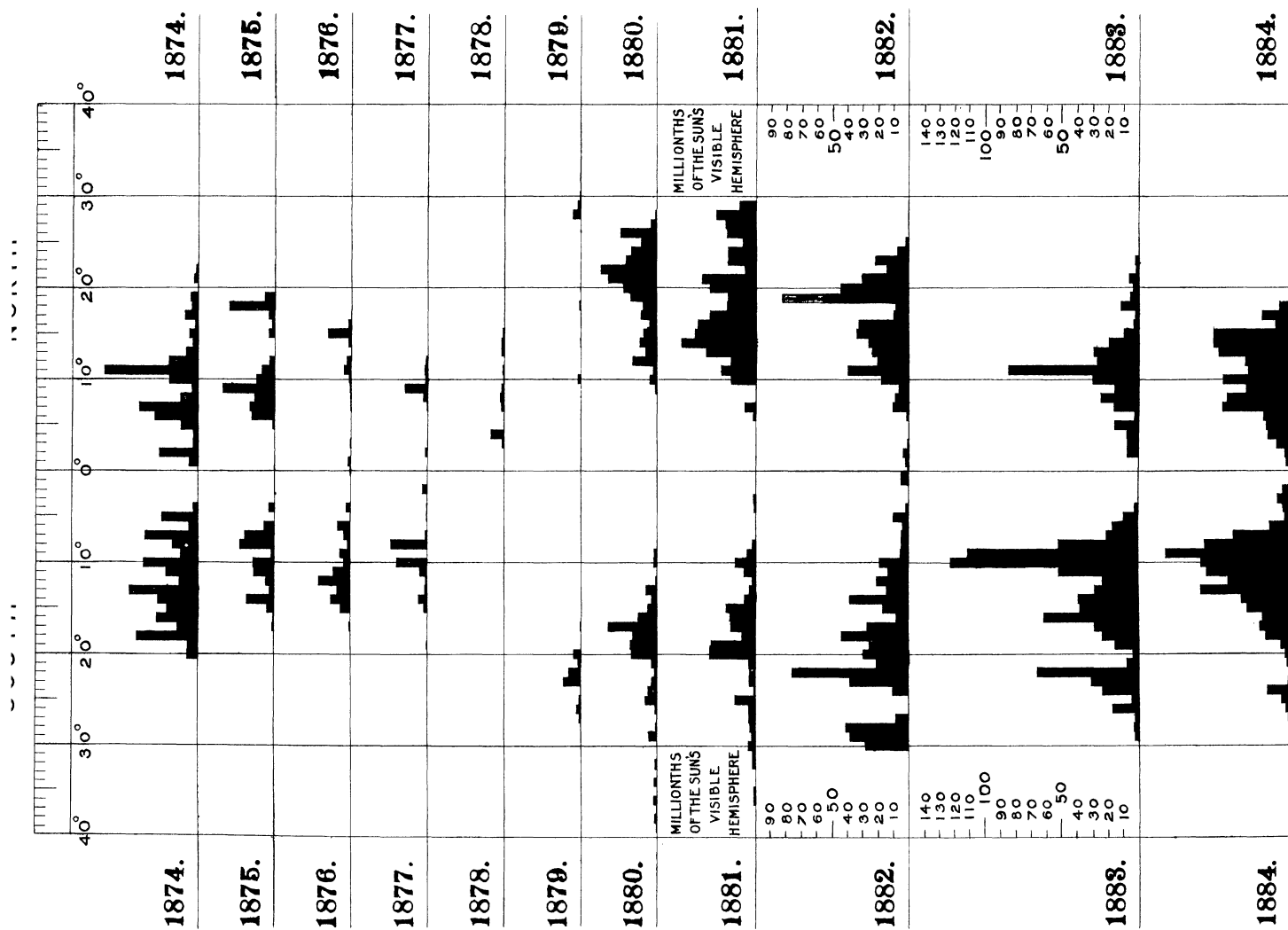
Mean Daily Area of Sun-spots for each Degree of Solar Latitude for each Year from 1874 to 1902 as measured on Photographs at the Royal Observatory, Greenwich.

(Communicated by the Astronomer Royal.)

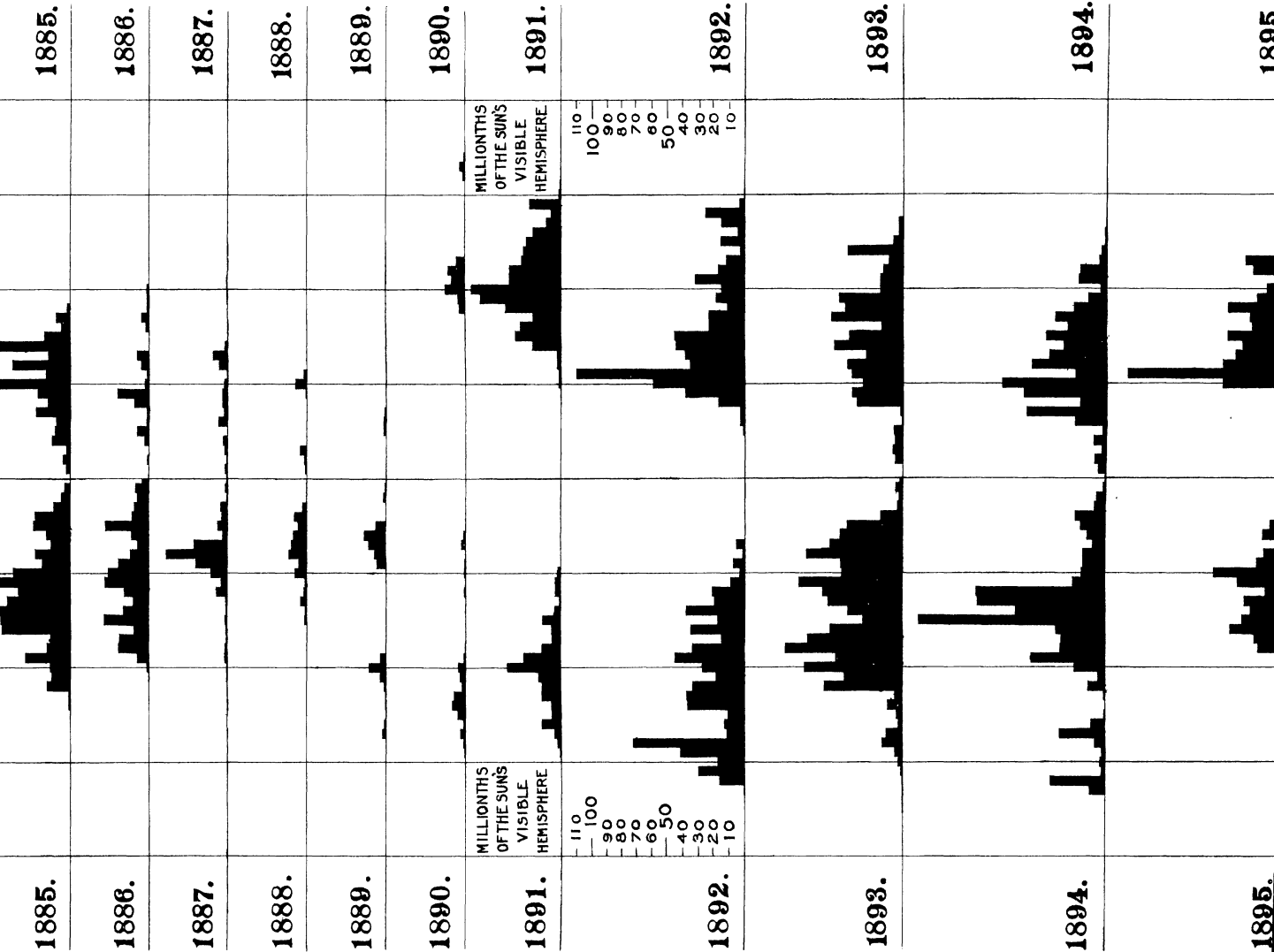
The following paper is an extension of one under a corresponding title communicated to the Royal Astronomical Society in November 1889 and printed in the *Monthly Notices*, vol. 1. pp. 10, 11. The table which follows has been formed by taking out the total areas of whole spots as expressed in millionths of the Sun's visible hemisphere for each degree of solar latitude for each year and dividing these by the number of days of observation to give the mean daily area. Plate 15 presents these mean daily areas in graphical form, mean daily areas under 0.7 being omitted. In apportioning the different spots to their respective latitudes the following rule has been observed. If the heliographic latitude of the centre of any single spot, or group of spots when measured as one, showed 0.5 or any higher figure in the decimal place, the entire area of the spot was taken as belonging to the next higher whole degree of latitude. If it showed 0.4 or any lower figure in the decimal place the entire area of the spot was taken as belonging to the degree of latitude indicated by the integral part of the number. Thus a spot at latitude 7.5 was taken as wholly belonging to latitude 8°, but one at 7.4 to latitude 7°.

The diagram and the tables bring out clearly several peculiarities of the distribution of spots. First of all for the period in question, viz. the twenty-nine years from 1874 to 1902 inclusive, spots in a higher latitude than 33° were at all times rare, and when seen were never large or long-lived. Taking them as a class by themselves they were seen irregularly, appearing at times which did not seem to bear any fixed relation to any one of the four chief stages of the sun-spot cycle—minimum, increase, maximum, and decline. Omitting these spots in very high latitudes—a term which would cover a zone 10° wide in each hemisphere, from 33° to 42°, for no spots were observed in a latitude greater than 42°—the years of maximum, 1883 and 1893, showed spots in practically every latitude between 30° N. and 30° S., and they were numerous from about 8° to 24° in both hemispheres. In the years following the maximum a marked tendency was shown for the spots to appear in lower latitudes. Thus in the periods of decline, 1885–8 and 1898–9, and in the corresponding period, 1874–6, of the preceding cycle, 22° was generally the highest latitude shown. In 1876, 1888, and 1899,

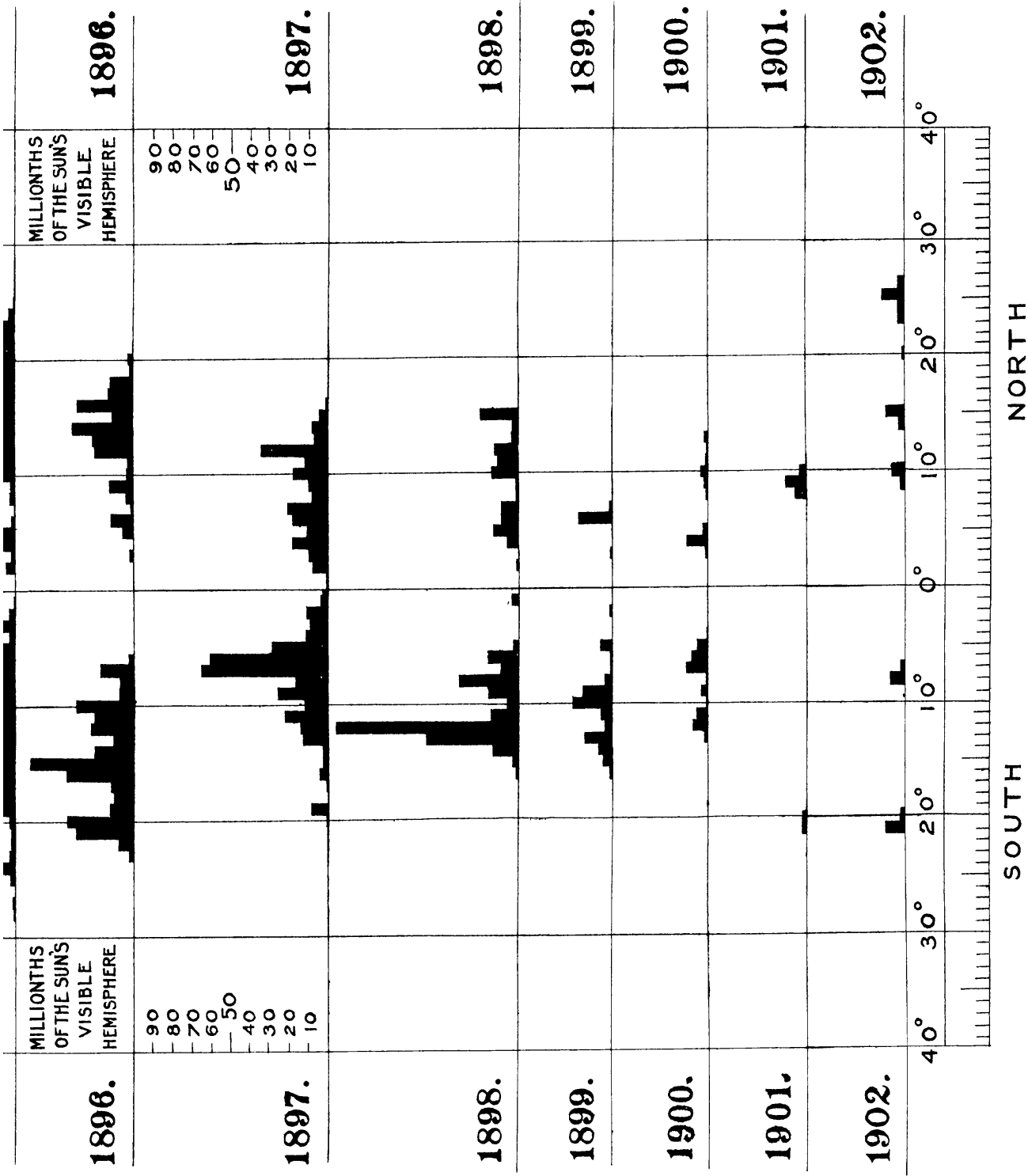
MEAN DAILY AREAS OF SUN-SPOTS FOR EACH DEGREE OF



SOLAR LATITUDE FOR EACH YEAR FROM 1874 TO 1902, AS MEASURED ON PHOTOGRAPHS AT THE ROYAL OBSERVATORY, (



GREENWICH.



that is to say, about one or two years before minimum, no spots were seen outside the limit of 18° from the equator. But immediately minimum was reached the spots became more widely extended in latitude owing to the occurrence of outbreaks in high latitudes. Thus at minimum each hemisphere, considered separately, showed two clearly defined spot-zones marked off from each other by a broad belt in which there were no spots at all. This was especially marked in the years 1889 and 1890, when the very region, centering about latitude 15° , which when an entire solar cycle is considered is the most prolific of the whole solar surface, was completely free from spots.

Of these two spot-zones in each hemisphere the lower appears to correspond to the series of spots of the expiring cycle. This series, two years before minimum, was confined within the 18° limit, and would appear at minimum to seldom attain a greater latitude than 10° or 12° . The spots with a latitude of 18° to 30° or more, on the other hand, seem to be the first members of the new cycle.

During the periods of increase, as 1879-81 and 1890-2, the equatorial belt was almost wholly free from spots, indicating possibly the complete disappearance of the last members of the old cycle. At maximum, however, the spots of the new cycle were most widely spread, and were seen even in the near neighbourhood of the equator, so that at maximum, and in the first stage of the decline after it, as in 1874, 1882-6, 1893-7, the equatorial region showed its greatest activity.

The comparison of the two hemispheres shows that on the whole the southern has been the more prolific; but that the critical points of the progress of the cycle have been marked earlier by the northern spots than by the southern. Thus in the two periods of increase in 1881 and 1891 the northern hemisphere had a marked advantage over the southern, and similarly in those of decrease the drop in the spotted area in 1885 and in 1896 was much more strongly shown in the northern hemisphere.

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Mean Daily Area of Sun-spots

LXIII. 8,

Latitude.	1874.	1875.	1876.	1877.	1878.	1879.	1880.
+40	...	...	...	...	...	...	...
39	...	...	...	...	...	...	...
38	...	...	...	...	...	...	...
37	...	...	...	...	...	...	...
36	...	...	...	...	...	...	...
35	...	...	...	...	...	...	0.5
34	...	...	...	...	...	...	...
33	...	...	...	...	...	...	...
32	...	...	...	...	...	0.3	...
31	...	...	...	...	...	...	0.03
30	...	...	...	0.5	...	1.0	0.1
29	...	...	...	0.2	...	2.2	0.3
28	...	...	...	...	...	5.3	1.0
27	...	...	...	...	...	0.4	4.0
26	...	...	...	...	...	0.4	23.8
25	...	...	...	...	...	0.1	10.3
24	...	...	...	...	...	...	16.7
23	...	...	...	...	...	...	20.0
22	1.2	0.2	...	...	...	...	36.4
21	2.4	...	...	...	...	...	31.0
20	0.1	...	...	...	...	0.3	21.9
19	5.0	6.4	...	...	...	...	17.1
18	4.2	29.8	...	...	...	0.9	8.7
17	8.4	4.2	...	...	...	0.1	10.2
16	1.9	1.6	2.2	...	...	0.3	4.5
15	5.8	3.8	15.3	...	0.8	...	8.6
14	3.7	...	2.0	...	2.1	0.5	11.9
13	8.0	...	0.1	...	2.1	...	7.6
12	19.7	3.4	2.8	1.5	...	...	15.9
11	62.1	8.5	4.7	2.1	1.1	...	2.3
10	19.2	12.6	1.2	1.6	0.7	2.1	4.2
9	4.2	34.7	0.9	14.8	2.0	...	1.2
8	12.1	13.4	0.4	2.7	2.6	...	...
7	39.3	16.7	0.4	1.0	2.2	...	...
6	28.6	15.2	...	...	...	...	...
5	11.6	1.6	...	...	0.6	...	...
4	3.4	0.2	...	...	9.1	0.2	...
3	2.9	0.2	0.6	0.1	1.5	...	...
2	25.8	...	0.1	1.6	...	...	...
1	5.8	0.2	1.6	...	0.1	...	...
0	...	0.1	0.1	0.2	0.1	...	...

June 1903. *for each Year from 1874 to 1902.* 455

1881.	1882.	1883.	1884.	1885.	1886.	1887.	Latitude.
...	...	...	...	...	...	...	+ 40
...	...	...	...	...	...	...	39
...	...	...	...	...	...	...	38
...	...	...	...	...	...	...	37
...	...	...	...	...	...	...	36
...	...	...	...	...	...	...	35
...	...	...	...	...	...	...	34
0·1	...	...	...	...	...	...	33
0·1	...	...	...	...	...	...	32
0·1	...	0·2	...	...	...	...	31
0·1	...	0·03	...	...	...	...	30
11·2	0·2	0·1	...	...	...	...	29
26·9	0·1	...	...	...	...	...	28
20·8	0·04	...	...	...	...	...	27
20·0	0·4	0·01	...	...	...	...	26
8·8	2·1	0·01	...	...	...	...	25
19·0	7·0	0·3	...	...	...	...	24
19·0	20·9	2·4	0·05	...	...	...	23
6·6	12·9	2·0	0·06	0·1	...	...	22
34·2	28·4	6·3	0·1	0·2	...	0·04	21
31·4	43·2	4·1	0·3	0·4	1·6	0·1	20
19·1	82·1	6·1	1·3	0·1	1·7	0·1	19
19·5	8·5	11·8	7·4	2·1	1·3	...	18
31·0	9·7	2·6	19·0	8·8	4·8	...	17
36·9	33·3	3·4	10·1	5·4	2·0	0·2	16
41·2	33·3	9·9	51·6	16·4	0·7	0·02	15
50·1	25·9	19·7	51·5	44·3	0·7	1·4	14
34·0	23·5	29·7	48·0	13·6	7·3	9·5	13
17·2	20·0	27·5	30·9	36·4	5·0	5·6	12
23·6	38·6	84·8	28·5	15·4	1·4	1·3	11
17·0	17·7	30·4	45·1	44·9	2·7	2·2	10
0·2	6·5	15·9	30·1	20·3	20·1	3·4	9
0·4	8·9	25·2	42·4	13·9	9·4	3·7	8
7·7	10·4	16·5	45·5	21·6	1·9	2·7	7
1·9	1·7	2·8	18·3	8·6	1·7	5·8	6
...	0·1	15·8	16·4	9·6	7·6	0·4	5
...	...	7·7	15·1	11·1	2·7	3·1	4
...	1·0	7·4	9·4	2·2	0·2	2·0	3
...	3·7	7·4	3·8	4·5	1·1	0·8	2
...	2·4	0·02	3·2	2·5	0·5	1·6	1
...	0·9	0·02	0·2	0·4	0·9	0·6	0

K K

456	Mean Daily Area of Sun-spots						LXIII. 8,	
Latitude.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	
+40 ^o	...	...	..	...	...	42 ^o 0'06	...
39	...	...	...	...	...	...	...
38	...	...	...	...	...	...	...
37	...	...	...	...	...	...	...
36	...	...	...	...	...	...	...
35	...	...	...	...	...	0'1	...
34	...	...	0'9	...	...	0'02	...
33	...	...	3'6	0'1	0'1	...	...
32	...	...	1'5	0'04	0'2	...	...
31	...	...	...	0'9	0'6	...	0'2
30	...	...	...	1'5	0'3	...	0'2
29	...	...	0'2	20'5	3'5	0'02	...
28	...	...	0'1	5'5	25'1	0'3	0'1
27	...	...	0'3	8'9	14'9	3'3	0'5
26	...	...	0'4	17'8	4'3	2'9	1'1
25	...	0'1	0'7	20'0	15'4	6'2	0'9	
24	...	0'3	0'5	23'2	2'9	35'1	3'5	
23	...	0'1	5'7	25'8	11'7	7'8	5'0	
22	...	0'02	10'4	31'4	17'0	12'6	17'4	
21	...	0'01	8'1	30'2	31'3	14'2	17'7	
20	...	...	12'6	46'5	14'4	14'2	3'8
19	...	...	4'4	38'4	18'1	40'7	11'7
18	...	...	3'6	32'6	11'2	35'6	21'4
17	...	...	0'4	15'9	22'5	45'3	33'1
16	...	...	0'1	27'0	22'5	13'5	25'1
15	...	...	...	29'3	44'7	34'1	38'7
14	...	...	...	17'3	43'8	44'4	27'3
13	0'2	...	...	2'2	37'8	23'4	36'2
12	0'7	0'01	...	2'4	35'1	35'5	47'4	
11	2'1	0'04	...	1'2	107'4	32'6	19'6	
10	7'4	0'2	...	1'1	58'1	25'3	66'3	
9	0'7	...	...	0'4	37'9	32'7	52'3
8	0'2	...	...	0'02	17'3	31'6	16'8
7	0'3	0'9	0'05	...	3'0	1'6	50'4	
6	0'3	1'5	...	...	3'2	0'9	19'8
5	0'7	1'5	0'02	0'04	1'2	5'4	2'5	
4	0'3	...	...	0'3	0'1	5'0	8'1
3	4'2	0'05	...	0'1	...	6'5	3'1	
2	1'5	...	...	...	...	5'0	7'3
1	1'0	0'1	...	0'05	...	0'4	5'0	
0	0'03	0'1	...	...	...	0'5	0'5

June 1903.		for each Year from 1874 to 1902.						457
1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	
...
...	...	...	...	...	...	...	0'04	
...	...	...	...	...	0'I	...	0'04	
...
...	...	...	...	...	...	0'02	...	
0'02	...	...	...	...	...	...	...
...	
0'I	...	...	...	...	...	...	...
...	
...	
...	
0'03	...	...	...	...	...	...	...
0'05	...	...	...	...	...	0'01	0'04	
0'I	...	0'03	...	...	...	...	0'I	
0'I	...	...	...	...	...	...	3'3	
0'7	...	...	...	...	...	...	11'0	
3'2	0'I	0'02	...	...	...	...	2'6	
30'7	0'I	...	...	...	...	...	2'8	
25'7	...	...	...	...	...	...	0'4	
11'9	0'I	0'04	...	...	...	...	0'3	
16'6	2'2	0'04	0'I	...	...	...	0'8	
23'4	1'5	0'2	...	...	...	...	0'04	
41'5	11'4	0'2	0'3	...	...	...	0'2	
27'9	12'8	0'03	0'5	...	...	...	0'I	
26'3	28'5	1'2	...	...	...	...	...
41'8	10'5	4'8	20'4	0'2	...	...	9'7	
32'3	31'1	8'1	3'4	0'2	0'03	...	2'8	
36'7	20'7	7'5	3'7	...	2'0	...	...
44'7	19'8	34'4	12'9	...	0'7	...	...
105'3	3'I	12'1	11'6	0'7	1'3	0'03	...	
44'8	3'4	17'9	14'4	...	3'5	3'6	6'2	
25'1	12'5	10'1	1'7	0'I	2'0	10'9	1'3	
3'0	4'0	8'7	0'9	0'5	0'8	6'4	...	
0'8	1'6	20'9	9'5	2'1	...	0'2	...	
1'9	11'7	18'2	9'4	17'9	0'I	...	...
7'2	5'9	11'5	13'4	0'I	2'7	...	...
8'6	0'I	18'7	6'3	0'4	11'0	...	...
2'3	2'2	10'3	0'I	1'0	1'4	...	...
4'6	0'5	8'2	1'2	0'2	...	0'3	...	
0'2	0'04	1'2	...	...	0'5	0'4	...	
0'I	0'02	1'3	...	...	...	...	...
								K K 2

458

Mean Daily Area of Sun-spots

LXIII. 8,

Latitude.	1874.	1875.	1876.	1877.	1878.	1879.	1880.
— 0	...	...	0·5	...	...	...	...
1	...	...	...	...	...	...	...
2	...	...	...	3·4	...	...	...
3	...	...	...	0·4	...	...	...
4	3·1	3·6	3·1	0·7	...	...	...
5	23·8	0·9	0·1	0·7	...	...	0·1
6	6·0	6·6	8·3	...	...	...	...
7	36·3	19·7	4·1	1·2	0·1	...	...
8	17·1	23·0	1·9	23·4	0·1	...	...
9	13·7	2·5	6·7	0·3	0·1	...	2·2
10	36·7	14·2	4·5	19·9	...	...	2·4
11	21·6	13·9	11·1	4·8	...	...	0·4
12	12·5	5·7	20·6	1·2	...	0·2	1·0
13	46·0	3·1	8·8	1·7	...	0·2	7·5
14	27·2	18·4	12·9	6·1	...	...	3·7
15	21·2	4·9	6·2	2·4	...	...	6·4
16	27·8	0·8	...	...	...	...	12·3
17	14·0	1·2	0·6	...	...	0·7	33·6
18	41·0	...	...	...	...	...	15·9
19	6·8	...	...	0·5	...	0·2	18·4
20	7·3	...	...	...	...	5·0	17·4
21	...	...	...	...	...	2·1	3·5
22	...	...	...	...	...	7·7	1·6
23	...	...	...	...	...	11·2	3·3
24	...	...	...	...	...	0·5	6·2
25	...	...	...	...	...	1·7	7·7
26	...	...	...	...	...	3·0	1·5
27	...	...	...	...	...	1·8	0·5
28	...	...	...	...	...	0·04	0·9
29	...	...	...	...	...	...	5·1
30	...	...	...	...	...	...	0·1
31	...	...	...	...	...	...	0·2
32	...	...	...	...	...	...	1·5
33	...	...	...	...	...	...	0·05
34	...	...	...	...	...	...	1·6
35	...	...	...	...	...	...	0·2
36	...	...	...	...	...	...	2·5
37	...	...	...	...	...	...	0·7
38	...	...	...	...	...	...	1·8
39	...	...	...	...	...	...	0·6
40	...	...	...	...	...	...	...

June 1903. *for each Year from 1874 to 1902.* 459

1881.	1882.	1883.	1884.	1885.	1886.	1887.	Latitude.
...	5.1	0.2	0.7	0.4	4.4	1.0	— 0
...	4.9	0.01	0.2	3.5	8.2	1.6	1
...	...	...	5.7	5.2	10.1	1.1	2
2.1	...	0.05	8.9	10.6	9.4	4.7	3
1.8	1.9	2.5	5.2	22.1	10.8	3.8	4
...	10.0	9.9	4.2	23.1	27.7	6.4	5
...	3.9	17.0	14.1	14.5	11.0	3.2	6
0.02	4.7	21.0	38.1	12.2	7.2	21.4	7
2.5	4.8	52.3	56.9	21.9	12.0	39.1	8
6.2	5.4	111.5	82.3	17.4	19.6	21.3	9
14.5	19.2	122.9	59.3	35.9	25.9	10.7	10
8.3	13.3	52.2	55.8	50.8	28.1	4.3	11
2.6	20.6	23.5	42.2	32.8	16.0	7.2	12
4.6	14.1	28.5	59.9	40.1	10.2	1.0	13
7.8	38.1	39.5	33.6	53.3	16.7	1.4	14
18.9	16.8	38.3	29.7	44.2	28.8	0.8	15
16.0	8.5	61.9	19.9	43.5	9.7	0.5	16
15.4	26.8	28.8	21.2	12.5	19.0	0.9	17
9.3	44.5	23.9	17.6	14.7	19.4	2.1	18
30.0	25.2	15.7	7.2	28.4	7.4	1.4	19
31.2	29.2	3.9	4.2	12.9	1.7	0.9	20
5.0	21.1	8.1	3.0	11.9	0.8	0.01	21
4.6	74.2	66.3	0.4	14.7	0.1	...	22
4.1	37.0	31.3	2.1	1.0	0.2	...	23
1.5	10.4	23.8	16.2	0.6	0.06	...	24
13.9	0.9	4.7	6.5	0.1	...	...	25
4.6	0.5	17.5	3.7	...	0.04	...	26
5.2	8.5	3.0	2.0	...	...	...	27
4.1	40.1	3.8	0.5	...	0.01	...	28
2.8	38.2	2.9	0.06	...	...	...	29
5.2	27.8	...	0.2	...	...	...	30
2.4	...	...	...	...	...	...	31
2.0	...	...	...	...	...	...	32
...	...	...	...	...	...	...	33
...	...	...	...	...	...	...	34
1.2	...	...	...	...	...	...	35
1.3	...	...	...	...	...	...	36
...	...	...	...	...	...	...	37
...	...	...	...	...	...	...	38
...	...	...	...	...	...	...	39
...	...	...	...	...	...	...	40

460	Mean Daily Area of Sun-spots					LXIII. 8,	
Latitude.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
— 0	0·1	0·2	...	...	...	2·1	0·05
1	0·4	0·6	...	0·1	...	4·4	2·0
2	0·5	1·6	...	0·1	0·04	2·7	6·1
3	3·0	0·3	...	...	...	3·6	7·2
4	8·1	0·5	...	...	...	14·1	19·1
5	5·4	6·6	0·2	...	0·05	35·7	15·7
6	8·5	13·8	1·2	...	0·3	36·9	11·5
7	9·9	11·0	2·6	...	5·2	43·3	8·1
8	11·5	7·3	0·3	...	1·5	61·8	14·2
9	5·1	5·9	0·4	...	7·5	40·0	14·1
10	7·3	0·1	0·5	1·6	3·4	39·3	15·1
11	1·1	0·05	0·03	3·5	9·0	64·7	20·7
12	1·9	...	0·01	3·6	20·7	51·3	81·8
13	4·0	...	...	0·9	19·4	48·2	81·2
14	0·8	...	...	5·0	36·8	35·2	56·9
15	1·2	...	...	12·8	17·1	25·7	118·0
16	0·1	...	...	6·7	34·1	46·4	31·5
17	0·1	...	...	7·4	5·5	60·7	27·8
18	0·01	...	0·6	11·8	33·1	74·9	28·6
19	...	3·7	1·3	23·1	44·2	43·0	46·9
20	...	11·0	4·2	32·7	26·6	62·9	19·6
21	...	3·8	3·8	14·2	18·0	37·5	4·6
22	...	1·5	2·4	5·2	33·1	50·4	10·8
23	...	0·7	7·5	10·7	36·8	5·1	1·0
24	...	0·4	8·4	5·2	36·4	9·5	0·2
25	...	0·1	5·2	5·4	10·8	3·8	0·9
26	...	1·3	1·6	12·4	12·9	3·2	8·9
27	...	2·4	3·5	3·5	11·2	10·8	28·9
28	...	0·03	1·4	2·2	70·6	13·2	6·4
29	...	0·02	0·9	0·9	40·9	5·1	2·2
30	...	...	0·3	0·3	17·1	3·0	3·2
31	...	...	0·1	0·3	29·2	1·5	2·1
32	...	...	0·1	0·2	15·8	0·5	34·8
33	...	...	0·1	0·3	0·4	0·1	9·7
34	...	...	0·3	0·2	0·3	0·4	...
35	...	...	0·1	0·1	0·01	0·6	...
36	...	...	...	0·1	...	...	...
37	...	...	...	0·02	...	...	...
38	...	...	...	...	...	...	...
39	...	...	...	40° 0·02	...	...	...
40	...	0·03	...	42° 0·02	...	...	...

June 1903. *for each Year from 1874 to 1902.* 461

1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
...	0.03	3.1	0.3	...	...	...	...
0.8	0.05	4.0	4.0	0.02	0.03	...	...
2.9	0.05	11.3	0.04	1.3	0.01	0.1	...
8.8	0.3	9.5	0.3	0.1	0.05	...	...
2.7	0.4	11.6	0.5	0.6	0.8	0.2	...
14.5	0.2	28.9	3.0	6.3	6.1	0.5	...
18.9	2.8	60.9	15.5	1.0	8.7	0.3	...
9.7	17.9	65.4	9.6	1.2	11.4	...	1.8
18.1	7.4	17.1	32.1	4.0	1.1	0.4	6.9
22.8	8.1	26.1	14.0	16.1	3.4	0.4	...
49.5	30.2	12.3	6.3	21.2	0.6	0.04	...
35.0	20.9	22.3	14.9	6.0	5.9	0.01	...
17.5	22.7	11.9	96.5	3.8	8.0	...	...
31.0	10.8	13.1	49.2	15.1	2.0	...	...
26.8	20.4	2.9	14.1	7.5	0.1	...	...
32.4	53.6	3.1	3.4	4.9	...	...	0.01
39.6	34.7	4.7	1.4	0.1	...	...	...
24.3	12.1	1.2	0.2	...	...	...	...
21.8	10.5	0.04	0.5	...	...	0.1	0.2
8.9	12.7	8.9	0.2	...	...	0.1	0.01
2.8	34.1	1.2	0.03	...	...	2.4	1.8
1.9	29.8	...	...	...	0.02	2.1	10.0
1.9	7.8	0.1	...	...	0.03	0.04	...
2.7	2.3	...	...	...	...	0.02	...
9.3	...	...	...	...	...	...	...
2.5	...	...	...	...	...	...	0.01
0.2	...	...	...	...	...	...	0.01
1.2	...	...	...	...	...	...	...
0.6	...	0.2	...	...	...	...	...
0.02	...	...	...	...	...	...	...
...
0.01	...	...	...	...	...	...	...
...
...	...	...	...	...	...	...	0.1
0.01	...	...	...	...	...	...	...
...	...	...	...	...	0.01	...	...
...
...
...	...	0.01	...	...	...	...	...
...
...

Royal Observatory, Greenwich:
1903. May 8.

Areas of Faculæ and Sun-spots compared with Diurnal Ranges of Magnetic Declination, Horizontal Force, and Vertical Force as observed at the Royal Observatory, Greenwich, in the years 1873 to 1902.

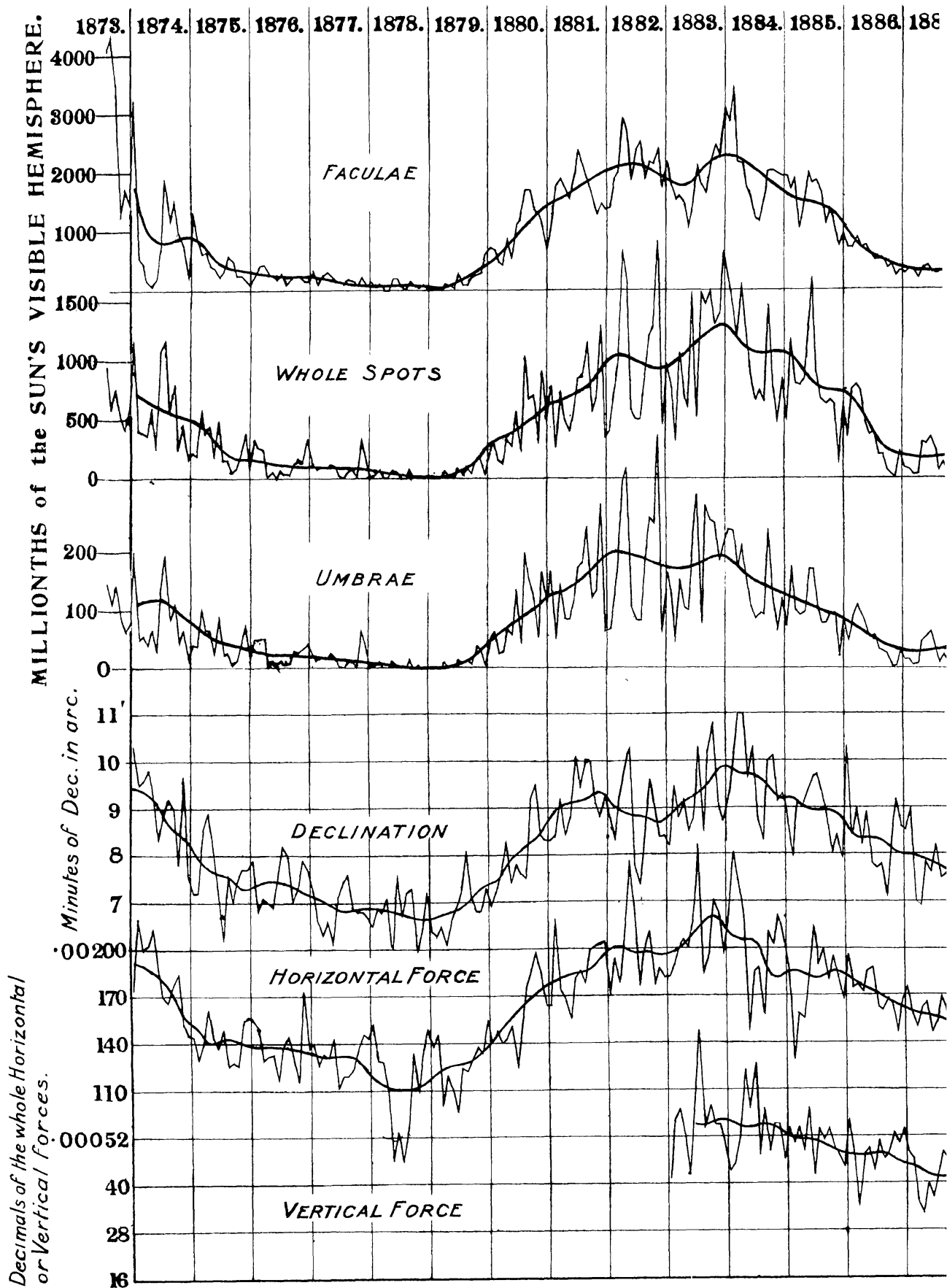
(Communicated by the Astronomer Royal.)

The following paper is an extension of one under a corresponding title communicated to the Royal Astronomical Society in November 1889 and printed in the *Monthly Notices*, vol. I. pp. 8-10. As in the plate accompanying that paper, which gave results up to 1888, so in Plate 16, attached to this, the three upper curves represent the areas of faculæ, whole spots, and umbrae respectively, and exhibit in a graphical form the results given on pages 106, 107, and 108 of the *Greenwich Spectroscopic and Photographic Results* for 1884, and in similar tables in the volumes for the succeeding years. For 1888 and subsequent years these results have also been communicated year by year to the Royal Astronomical Society, the figures for 1888 appearing in Table I. in the *Monthly Notices*, vol. xlix. p. 380. The mean areas for each of the three orders of solar markings have been formed by taking the means of the areas as measured upon the solar photographs, corrected for foreshortening, and reduced to millionths of the Sun's visible hemisphere for each day of observation throughout each synodic rotation of the Sun. The commencement of each rotation is defined by the coincidence of the assumed prime meridian with the central meridian, the assumed prime meridian being that meridian which passed through the ascending node at mean noon, on 1854 January 1, and the assumed period of the Sun's sidereal rotation being 25.38 days.

The ordinates for the three curves represent, therefore, the mean daily areas for each synodic rotation expressed in millionths of the Sun's visible hemisphere. The scale on which the ordinates have been drawn is five times as large for the nuclei as for the whole spots, and twice as large for the whole spots as for the faculæ, in order that the variations in each curve might be equally distinct; for the areas of the whole spots are, on the average, about five times as great as those of the nuclei, and of the faculæ rather more than twice as large as of the whole spots. A smooth curve has also been drawn for each of the three orders of phenomena, the ordinates for which correspond, at any given rotation, very nearly to the mean of the areas for the given rotation and the six preceding and following rotations, representing thirteen rotations, or nearly a year.

From 1873 to the end of 1881 only the photographs taken at the Royal Observatory, Greenwich, were available for measurement, but from 1881 December 21 the gaps in the Greenwich

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